1. (34 pts) A generator is connected to a transmission line through a transformer having a rated turns ratio (ratio of line-to-line voltages) of 20 kV (generator side) to 100 kV (transmission line side). The generator has a per unit reactance of 0.08 pu on a 19 kV, 50 MVA base. Select the base voltage on the transmission line side to be 110 kV.
   a. Compute the base voltage on the generator side.
   Solution:
   \[ V_{\text{base gen}} = 110 kV \cdot \left[ \frac{20 kV}{100 kV} \right] = 22 kV \]
   b. Compute the pu reactance of the generator using a 100 MVA system power base.
   Solution:
   \[ X_{pu2} = X_{pu1} \cdot \left[ \frac{V_{\text{base 1}}}{V_{\text{base 2}}} \right] = 0.08 \cdot \left[ \frac{19 kV}{22 kV} \right] \cdot \left[ \frac{100 MVA}{50 MVA} \right] = 0.11934 \]

2. (32 pts) A large capacitor is connected in parallel with a resistive load, and both of them are directly connected to a synchronous generator. Draw the phasor diagram corresponding to the operation of the synchronous generator. Show phasors corresponding to \( V_t \), \( E_f \), \( I_a \), \( jX_s I_a \). Also show the power angle \( \delta \). Assume the phasor \( V_t \) is the reference.
   Solution:
   ![Phasor Diagram]
   The angle \( \delta \) is between \( E_f \) and \( V_t \).

3. (34 pts) A three-phase, 60 Hz synchronous generator has a synchronous reactance of 0.95 per-unit and negligible resistance. The terminal voltage of the generator is \( V_t = 1.0 \angle 0^\circ \), and the internal voltage of the generator is \( E_f = 1.514 \angle 30.45^\circ \). The magnitudes of both voltages given are in per-unit on bases consistent with the given synchronous reactance. The three-phase power base is 100 MVA. Compute the real power out of the machine in (a) per-unit (24 pts) and (b) three-phase MW (10 pts).
   Solution:
   (a) The per-unit power is given by:
   \[ P = \frac{\left| E_f \right| \cdot \left| I_a \right| \cdot \sin(\delta)}{X_s} = \frac{1.514 \cdot 0.8076 \cdot \sin(30.45)}{0.95} = 0.8076 \]
   (b) The 3-phase power is given by 100 * 0.8076 = 80.76 MW.